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An approach to Avoiding Train Collision in Railway Sectors using Multi Agent System

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Abstract

In the recent years there is a huge improvement happening in the field of signaling and tracking for train traffic. Even efforts have been on, still there is a continuing story of railway disaster frequently happening. The proposed work comes with a novel suggestion for this problem. The current techniques employ the basics of older systems like blocking system and now partly GPS technology has been incorporated in that. Our proposed novel system uses the concepts of Multiple Mobile Agents usage to enable collection of all position information of various trains and get processed the received information and then taking the decision of controlling the movements of trains by themselves during a collision situation occurring. The advantage of our proposed system is that Agents not only collect information but also provide enough intelligence to effect collision avoidance of trains. The details are presented in the paper.

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Keywords: Multi Agents ; Collision Avoidance ; Agent Access Environment; Jade;

1. Introduction:

Train tracking is one of the important issues towards avoidance of collisions. There are many tracking devices reported like axle counter, track circuit incorporated for identifying the passage of trains, etc. Also many systems like Absolute blocking system, Automatic Blocking system currently exist in Indian railways towards tracking the trains and for signaling updates. These existing systems provide information only on the

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train which is somewhere between blocks (section in rails) but doesn't provide the exact location of trains. The entire existing system purely depends on these tracking devices. So if these tracking device do not respond then the whole signaling system might collapse and it may lead to train collisions. The proposed system therefore uses the concept of GPS [1][2] and the trusted Agent technology which has the advantage of self learning & motivation ability. This enables providing adequate information about the train's position, back to the controller in a short span of time using the existing trusted communication channels.

2. Overview of Proposed System:

The proposed system concentrates on the area of collision avoidance of trains. Multi Mobile Agents are dedicated for this application. The proposed system uses Mobile agents towards collecting the positional data's pertaining to each train and updates the same back in the receiver side. So the entire network comes to know of the exact locations of all trains. If different trains use the same track and closing nearer to each other within a predetermined short distance, the trained agents will immediately identify the possibility of collision occurrence and immediately send back information to the respective trains for enabling stopping such trains in such crucial situations. The advantage of the proposed system is that it can be easily synchronized with the existing system so implementation cost will get reduced.

The proposed system comes with three modules

1. Train Environment Module
2. Control Room Environment Module
3. Agent Access Environment Module

2.1. Train Environment Module

Train Environment Module shown in Fig.1, resembles the real train environment by having GPS modules for getting positional information of trains. It consists of RF Transceiver (APC 220) which enables communicating the positional information to the remote control room in the corresponding frequency band of 431MHz to 478 MHz. This information will however, be communicated to the control room environment on the basis of requests by Agents. Train Engine mechanism part just resembles the trains running condition. Arduino [5] the open source microcontroller board plays an important role in this environment. Using Serial interfacing, this Arduino board [6] communicates with GPS, RF Transceiver and completes all the operations.

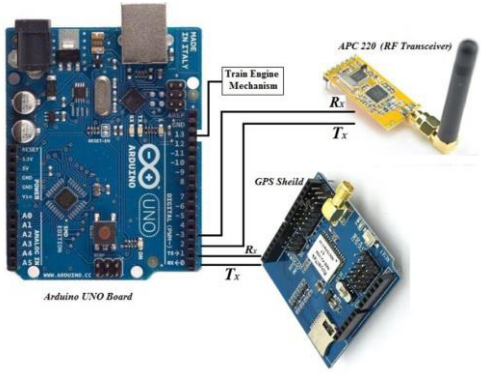

Fig. 1. Blocks of Train Environment Module

2.2. Control Room Environment Module

Control Room Environment Module shown in Fig,2, is nothing but a Visual front end, wherein the user can easily visualize the positions of different trains. A processing software has been developed for creating this application. This environment module functions as a mediator between two environments. Agents access the trains and the corresponding results from the trains will be updated by using this environment. The backbone behind all this operation is a MySQL Database. Our proposed system uses two database tables for the system. One table completely take care of the train's update's and another table take care of Agent related operations. Processing software periodically updates and collects the data from these tables and provide the visuals in the control room environment.

Fig. 2. View of Control Room Environment Module

2.3. Agent Access Environment Module

This module provides the environment where the complete agent related operations take place. The Back bone operations for these environments are facilitated by JADE [4]. JADE is an Agent Programming tool which runs on Eclipse Software. Agent Creation, Agents assigning job, collecting data from the Agents everything are operated in this environment only. And also predicting the collision occurrence between the trains is carried out in this environment only. Necessary action for the avoidance of collision occurrence is also carried out in this environment only [3]. This Environment is very important in our proposed System. Agents collecting information from the trains will be carried out as shown in Fig.3.

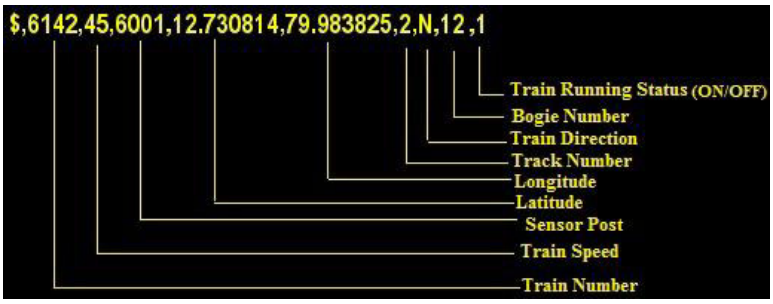

Fig. 3. View of Train data collection by Agent

3. Proposed System Blocks:

The proposed system uses the following software and hardware modules and this is shown in Fig.4.

3.1. Software Modules

1. Java Agent Development Framework (Jade)(Agent Programming Language)
2. Eclipse SDK Toolkit
3. Processing Software
4. My SQL Workbench
5. Arduino IDE
6. Google Maps

3.2. Hardware Modules

1. Arduino Boards
2. Global Positioning System(GPS)
3. APC 220(RF Transceiver)

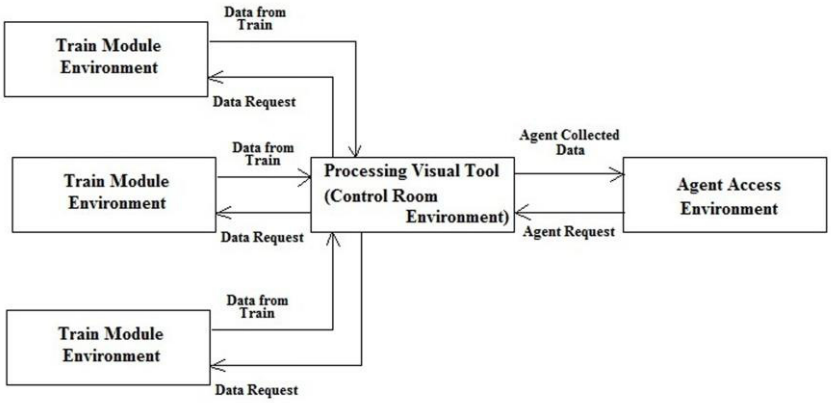

Fig. 4. Blocks of the proposed Collision Avoidance System

Each Agent is created in the Agent Access Environment and each will be assigned with the job of collecting the positional information from different trains which just cross the Sensor posts. A sensor post is a module which has a train identification module [1] which enables identifying the trains that is just crossing it and it will communicate with the train and update their identity to the train. So when train crossing each sensor post it will get updated with sensor post identity like. 6001, 6002 etc. Agents will be assigned with the sensor post number and collect the positional information from those trains. Once the Agent [4] comes out from the Agent Access Environment it will update the database. Control Room Environment will collect this information and sends the agent to the corresponding Train Environment Module to collect the information from the train. Once the Information is collected from the train, Agents are again sent back to agent access Environment to handover the collected information. Now each data will be processed to determine if any train sharing the same track number and also the distance between the trains is less than 2 Kms, then agents will be again sent back to the Train module for making Emergency. This process will lead to Collision avoidance.

4. Algorithm of Proposed System:

1. Multi agents will be created in the Agent Access Environment.
2. Each created agent assigned with the job of Collecting data from specific train.
3. Now each Agent will mobile to access their corresponding train(node) through MySQL database and RF Wireless Transmission.
4. After reaching the train(node) each Agent collect the trains position data from Train Module Environment and return back to the Agent Access Environment.
5. Collected position data from each train will be processed and Distance between each trains will be analyzed and taking decisions of stopping the trains based on distance between trains and their tracks.
6. If any trains sharing the same track and distance between them is small then alert sent back to the train through Agent for stopping the train.
7. During all these process, status of operation is updated in the MySQL and the same will be visual in the control room Environment in real time.

5. Results of Proposed System:

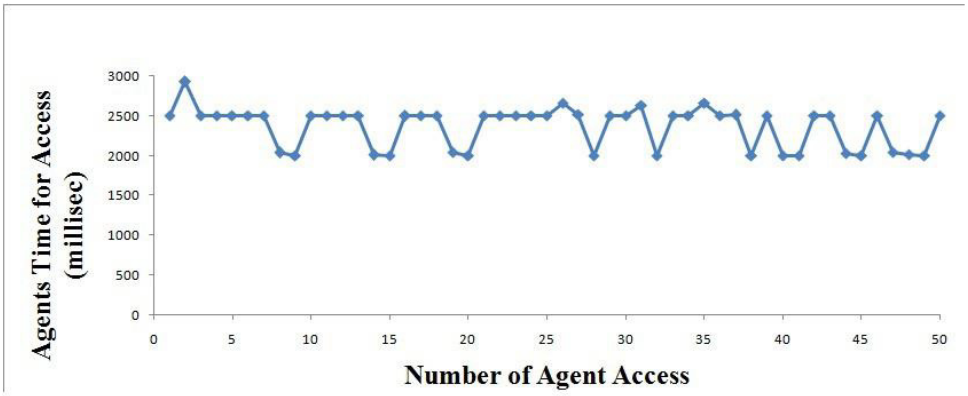

Fig. 5. Time Taken for Agents to Access Data

Agent for collecting the information from the train it has to travel through Control Room access and reach the train and get the positional update from train and again reach back to Agent access Environment hardly its taking 2 sec for operation. In this time, databases getting updated with this information and visual software update of the train information are shown in the screen. Fig 5 shows the access time taken by agents to collect information.

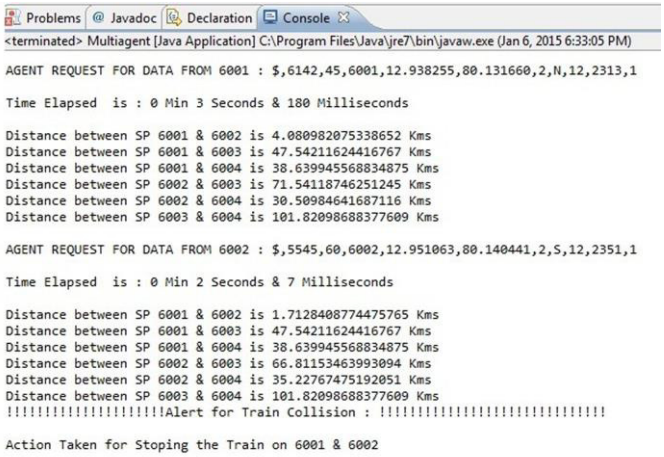

Fig. 6. A print screen of Results of Agent Access

Fig 6 shows a screen shot of output console of the proposed system, during each sequence, Agent requests will be sent to different sensorposts. Within the time gap, the required information is sent back from the Train Environment Module which is clearly visual in the figure. And also the distance between trains on that instant is measured by using agent environment module and if the distance between the pair of trains is less than 2 Kms then Alert is provided and action taken for stopping both the trains and this is clearly visual in the figure.

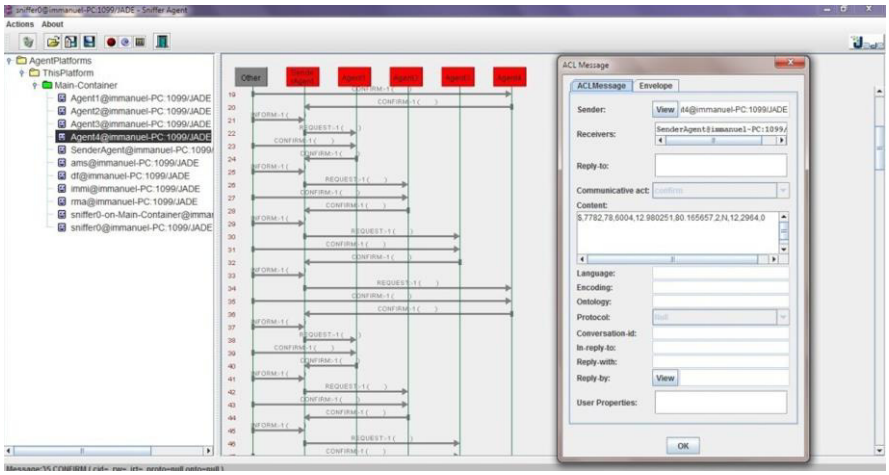

Fig. 7. A Screen Shot of Sniffer Agent View of Access of Agent Communication

Fig 7 shows the operation of Multi agents for transferring their information between each other. Sender Agent asking for request from Agent1 regarding the position of Trains @ Sensor Post 6001.After executing operation for finding the trains position,agent1 Send back the requested train's position information back to the Sender Agent. Like above, the sender Agent will talk with remaining agents and collect the information of available each train's position and the same will compare to find the distance between each other. So the Multi Agent System (MAS) concepts implemented in the proposed work to execute the function of collision avoidance.

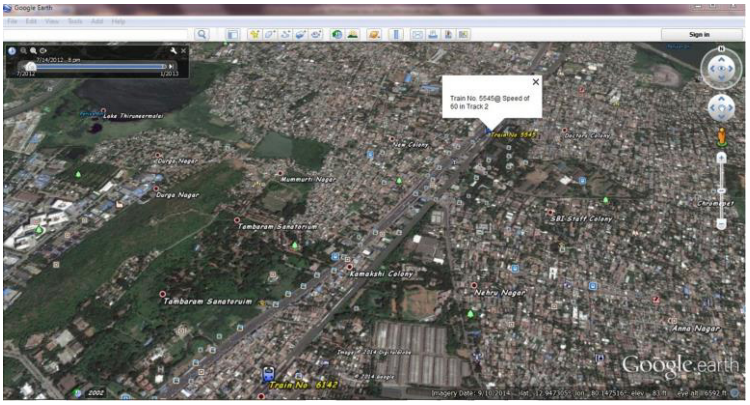

Fig. 8 Screen shot of two trains visual on Google earth

Fig 8 shows the trains positional information of different trains which is collected by Agents will Plot in the Mapping Visual Tool. And also when user clicks on icon of each train he will get the information's like corresponding train's track number and the current speed by which train is travelling.

6. Conclusion:

The proposed system uses the Multi agent Concepts and collects the train information periodically or on Demand and this information taken to the Agent Environment to determine the possibility of Collision occurrence and then take necessity action if there is a chance of collision. Agents have the great advantage of learning and motivation and so definitely it will return with train's information properly to the node. And also proposed system comes with a visual tool for showing all the current information of the train systems to the user.

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